UP IN SMOKE[1]

Grade Levels: 4-6 **Time:** 30-40 minutes

Purpose
To demonstrate that the air we breathe may be polluted due to the burning of materials.

Through the simple demonstration of a burning candle, this lesson helps students recognize that burning any material results in the generation of air pollution (both indoor and outdoor) even though it is not always easily seen. The lesson is also important for building basic observation and prediction skills, and connecting to other lessons regarding matter and its changes, and other air pollution concepts.

Background
When something such as a candle, paper, or fossil fuel burns, it changes from one kind of material to another. Many of the materials formed are air pollutants that can harm humans, other animals, and plants at certain concentrations. In the case of a burning candle, the wick, wax, and oxygen are burned and materials such as water vapor, particulate matter (e.g., soot), and carbon monoxide are formed. Water vapor is harmless; however, particulate matter and carbon monoxide are air pollutants.

The burning process becomes more complex when gasoline or diesel fuel is burned because many more different kinds of gases, vapors, and particles are formed, including nitrogen oxides and sulfur oxides, which are two important air pollutants.

Objectives
Students will:
1. Draw a picture of a burning candle.
2. Identify two materials that are burned and two materials that are formed from a burning candle.
3. Identify five combustion sources that contribute to air pollution.
4. Explain the result of placing an inverted glass cup completely over a burning candle.

Materials
- Candle (small enough to fit inside a small clear glass cup)
- Small clear glass cup
- Matches or lighter
- Paper towel

Preparation
1. Place the paper towel on the table.
2. Place the candle on the paper towel.

[1] Adapted from Project FEED, Families Exploring Environmental Dilemmas, San Joaquin County Office of Education, 2000.

Activity

1. Hand out the "Up in Smoke" Worksheet and light the candle. Ask students: What do you see as the candle burns? Have students describe and draw a picture in section #1 of the worksheet of what they see as the candle burns. Have students compare ideas and notes.

2. Ask students to predict what will happen if the bottom of the glass cup is placed an inch above the flame. Have students write their prediction in section #2 of the worksheet.

3. Place the glass cup approximately an inch above the flame (see Diagram 1 below). Have students write what happened to the glass in section #2 of the worksheet. *(Soot collects on the bottom of the glass cup.)*

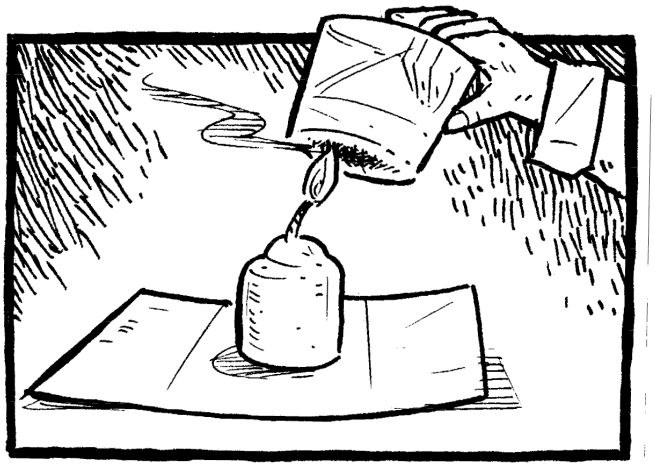

Diagram 1

4. Discuss where the soot goes when the glass wasn't placed above the flame. *(It goes into the air that we breathe.)*

5. Ask students to make a list in section #3 of the worksheet of other things that burn fuel and may release soot, carbon monoxide, and other pollutants into the air. *(Cars, trucks, construction vehicles and equipment, agricultural vehicles and equipment, portable and stationary engines, trains, airplanes, stoves, fireplaces, lawn equipment, power plants, etc.)*

6. Explain that burning is a chemical reaction that requires oxygen and fuel and that oxygen is an invisible gas in the air. Ask students: What is the fuel that a candle burns? *(Oxygen and wick.)* What happens to the fuel when it burns? *(They turn into different materials such as water vapor, soot, and carbon monoxide.)* What happens to the candle? *(The wick burns and the wax melts.)*

7. Gently blow out the candle, then light a match and quickly hold it in the stream of smoke about 2 inches above the wick. The flame will ignite the gases in the smoke and re-light the wick. *(Note: This works only if the candle is quickly re-lit because the flammable gases generated from the previously burning candle have not fully dissipated away from the candle.)* Ask students: What happened? How did the wick start burning without direct contact with the flame? *(Some gases in the smoke are flammable and are still in high enough concentration near the wick to be ignited. The match lit the gases and the flame traveled back to the wick.)*

8. Ask students to predict what will happen when the candle is covered with the glass cup. Have students write their prediction in section #4 of the worksheet.

9. Turn the glass cup upside down and cover the burning candle with the inverted glass cup (refer to Diagram 2 below). Have students write what happened in section #4 of the worksheet. Ask students: Why does the candle burn out? *(The flame used up all the oxygen inside the inverted glass cup.)*

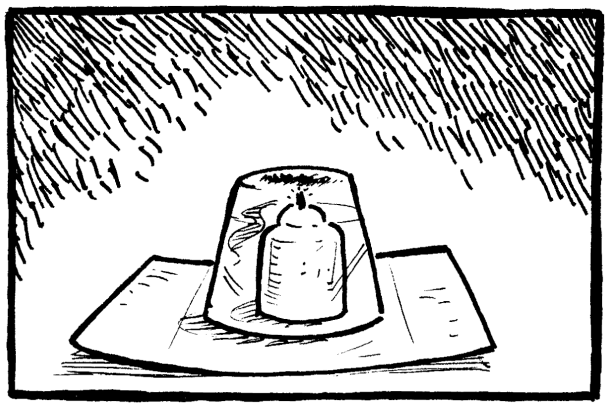

Diagram 2

Student Understanding and Reflection

1. Discuss questions on the worksheet and solicit student responses.

2. Have students reflect on their learning:
   (a) I discovered that burning causes…
   (b) I was surprised to learn that air pollution occurs…
   (c) How has my idea of using gas-power vehicles and equipment changed?
   (d) I am interested in learning more about…

Wrap Up

Explain that the burning candle demonstrated that matter changes form when it is burned. The flame uses the wick and oxygen as fuel and the result is the formation of such materials as water vapor, soot (particulate matter), and carbon monoxide. Water vapor is harmless; however, particulate matter and carbon monoxide are air pollutants that can harm humans and other living things. Burning generates air pollution whether it is from burning gasoline or diesel in cars, trucks, factories, or power plants, or burning paper, wood, or natural gas in fireplaces.

Explain that particulate matter is one type of air pollutant in California and can be coarse particles such as wind-blown dust or fine particle combustion products such as soot. Ask students: how many pounds of particulate matter come from human-made sources each year in California? *(About 3 billion (3,000,000,000) pounds per year.)* Discuss where all that air pollution might go. *(In homes, cities, towns, mountains, forests, beaches, valleys, etc., wherever fuel is burned, and eventually into our lungs.)* This air pollutant can harm humans and other animals if a high enough concentration is breathed into the lungs.

Finally, explain that air pollution can occur indoors or outdoors and that only by developing an awareness and understanding on what and how air pollution is generated can they begin to think about what they and others (i.e., relatives, friends, industry, government, etc.) can do to reduce it.

California Science Content Standards, K-12 (Adopted 1998)

Concepts of the lesson may be connected to the grade-specific content standards below:

Grade Four

6c. Formulate and justify predictions based on cause-and-effect relationships.

Grade Five

1a. Students know that during chemical reactions the atoms in the reactants rearrange to form products with different properties.

6b. Develop a testable question.

Grade Six

7e. Recognize whether evidence is consistent with a proposed explanation.

Worksheet: Up in Smoke

Name _____ Date _____

1. Describe and draw a picture of what happens as the candle burns.

2. What will happen when you hold a glass above the flame? Prediction:

   What did you observe?

3. What other things burn fuel and release smoke or other pollution into the air?

4. What will happen when you cover the candle with the glass? Prediction:

   What did you observe?